

## Manufacturing of Cutting Saw Machine for Aluminum

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### ABSTRACT

Aluminum is a metal material that is widely used in various industrial sectors, such as automotive and construction, because of its lightweight and corrosion-resistant properties. However, aluminum cutting often faces technical challenges, such as overheating that can affect the quality of the piece. The research aims to design and build a prototype of a cutting saw machine specifically designed for aluminum materials, with a focus on efficiency, low cost, and ergonomics. The research uses an engineering experiment approach with the stages of CAD-assisted design, component manufacturing, and performance testing. Prototypes are tested to evaluate cutting speed, operational stability, and energy efficiency. The results show that the machine is able to cut aluminum at a speed of 86.13 mm/min, high energy efficiency, and adequate stability. This study fills the gap of previous research that focused more on heavy metal cutting machines, such as steel. These findings make a significant contribution to aluminum processing technology, especially for small and medium-sized industries. This study recommends the development of automation systems and the use of alternative materials to improve engine performance.

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## **INTRODUCTION**

Aluminum is a very important metal material and is widely used in various industrial sectors, including the automotive industry, aircraft, construction, electronics, and household appliances. The main advantages of aluminum lie in its lightweight, corrosion resistance, as well as its ability to be recycled without losing quality. In addition, aluminum also has a fairly good level of strength, although it is not as tough as steel. Its widespread use, especially in applications that require lightweight and strong materials, has given rise to the need for more efficient and precise aluminum material processing technology, especially when it comes to cutting (Buriyanta & Safhriana, N.D.; Price, 2023).

Cutting aluminum is not a simple thing, as this process must consider various factors such as the thickness of the material, the type of cutting performed, as well as the operational conditions of the cutting machine. Aluminum has unique physical characteristics, such as high friction temperatures that can cause the material to stick to the saw blade. Therefore, in the manufacture of cutting saw machines for aluminum, the machine design must be able to overcome these various technical challenges. One of the biggest challenges is reducing the excess heat generated during cutting, which can affect the quality of the cut and shorten the life of the saw blade (Suzen & Hasdiansah, n.d.).

In the development of aluminum cutting saw machines, one of the technologies used is the regulation of the rotation speed of the saw blade. The machine that can adjust the rotary speed according to the thickness of the material can improve the cutting efficiency and reduce the formation of overheating. Additionally, the use of special materials for saw blades, such as tungsten carbide, has been shown to be effective in improving the resistance of the saw blade to wear and corrosion. Innovation in the design of chainsaws that are more efficient and environmentally friendly is becoming increasingly important, given the increasingly stringent regulations related to emissions and energy use in the industry (Wibowo & Haryadi, n.d.).

Research on the manufacture of aluminum cutting saw machines focuses on the development of tools that are not only cost-efficient, but also in terms of cutting speed and accuracy. The use of computer-aided design (CAD) technology allows researchers to design high-precision machines that can produce cuts with very tight tolerances. In addition, ergonomics and operator safety factors are also the main focus in the design of this machine. Sawing machines for aluminum must be able to provide comfort and safety for the operator, given the risks associated with high-speed machines and heat-producing cutting processes (Iskandar & Damanik, n.d.; Prasetya & Harjanto, 2020).

Based on this background, the research aims to design and build a cutting saw machine for aluminum that can be used efficiently in small and medium industries (SMEs). The developed machine is expected to help SMEs to reduce their dependence on cutting machines that are expensive and not always according to their needs. The resulting machine prototype will be tested under

operational conditions to ensure that it can meet the desired criteria of efficiency, cost and cut quality. Thus, this research is expected to make a significant contribution to the development of the aluminum processing industry in Indonesia, especially for SMEs who need more efficient and affordable cutting technology (Haryani & Handayani, n.d.).

## **THEORETICAL FRAMEWORK**

Aluminum cutting is one of the important processes in metal material manufacturing. Cutting saw machines are used to cut this material with high efficiency and accuracy. Therefore, an understanding of the various aspects related to cutting, machine design, as well as the characteristics of aluminum is essential for the development of an effective cutting saw machine.

### **1. Characteristics of Aluminum in Cutting**

Aluminum is a lightweight metal that has a relatively low melting point and is easy to form, yet has high thermal conductivity, which makes it more susceptible to heating when cut. Research by (Tanaka, 2019) indicates that aluminum, although lightweight, can undergo significant thermal deformation when cut using a machine at improper speeds. This affects the quality of the cut and the service life of the cutting tool. Types of Cutting Saws Cutting saws for metals are usually divided into two main categories, namely bandsaw saws and circular saw saws. Bandsaw saws are widely used for cutting materials of varying thicknesses, and they have advantages in terms of flexibility and the ability to make more precise cuts. However, despite its advantages, the use of bandsaw saws requires good engine design to reduce the risk of damage to the material and the machine itself due to excessive heat buildup. Circular saw machine semes have advantages in operational speed, but they tend to produce higher vibration and heat. The choice of the type of sawing machine largely depends on the characteristics of the material and the purpose of the cut.

### **2. Saw Blade Desaiology**

The design of the saw blade is an important factor in the aluminum cutting process. The saw blade used must have sufficient resistance to high temperatures and wear that occurs during the cutting process. Research conducted by (Fadilah & Azman, 2021) revealed that the use of materials such as tungsten carbide on the saw blade can reduce excess heat formation and improve wear resistance. With the right saw blade design, the cutting saw machine for aluminum can operate more efficiently and produce smoother cuts.

### **3. The Effect of Cutting Speed**

One of the important factors that affect the quality of aluminum pieces is the cutting speed setting. Cutting speeds that are too high can increase overheating, which can affect the integrity of the material and the saw blade. Conversely, cutting speeds that are too low can result in longer cutting times and reduced efficiency. Study by (Choi et al., 2018) shows that the optimal cutting

speed setting can improve the cutting efficiency and reduce the excessive heat formation in aluminum materials.

#### 4. Innovation in Cutting Machine Pepada System

The cooling system plays an important role in aluminum cutting. An efficient cooling system can reduce the heat generated during the cutting process and maintain temperature stability in the material and cutting tool. As technology evolves, various new cooling systems, such as the use of water- or oil-based coolants, are beginning to be integrated in cutting saw machines to improve performance and extend the service life of the saw blade (Lehtinen & Kallio, 2018; Pratama & Wibowo, 2020; H. Wijaya, 2020).

## **METHODS**

This study uses an engineering experiment approach to design, modify, and test a cutting saw machine specifically designed for aluminum materials. This approach is carried out in stages, starting from data and material collection, design design, to engine performance testing. Each stage is described in detail as follows:

### 1. Planning Idea and Idea Stage

In the early stages, research begins by formulating planning ideas and ideas. This process involves identifying user needs, namely the need for a cutting saw machine that is capable of producing aluminum pieces with high precision, energy saving, and time efficiency. Initial data were collected through literature studies and direct observations of the aluminum cutting process using conventional methods, such as hand saws or simple cutting machines.

### 2. Data and Material Collection

Technical data relevant to aluminum materials, such as tensile strength, hardness, and thermal properties, are collected from various literature sources. In addition, the materials that will be used for the manufacture of the machine, such as steel for the frame, electrical components for the drive motor, and special saw blades for aluminum, are selected based on the appropriate specifications. The material collection process is carried out taking into account applicable standards, for example ASTM for metals and mechanical materials (Putra & al., 2020).

### 3. Designing the Design of the Cutting Saw Machine

At this stage, the initial design of the machine is made using computer-based design software (CAD) to produce precise engineering drawings. The design includes determining the dimensions of the frame, transmission system, cooling system, and operator safety protection. Each design element is analyzed using the Finite Element Method (FEM) to ensure the strength and stability of the machine components (Nurhadi & al., 2019).

#### 4. Preparation of Tools and Materials

Once the design is complete, the next stage is to prepare the tools and materials for the production process. The equipment used includes lathes for shaft processing, welding machines for frame jointing, and laser cutting machines for precision of small components. The main raw materials, such as steel plates, aluminum, and electronic devices, are calibrated and checked for quality before use (Sulaiman & al., 2018).

#### 5. Machine Manufacturing and Assembly

The manufacture of the machine is carried out by following the design that has been made. This process includes cutting, turning, welding, and assembling components into a single machine. The main focus in this process is to maintain dimensional rigor and ensure that all components are functioning properly. After the manufacturing is completed, the machine is assembled in a logical working order, from the installation of the drive motor to the installation of the saw blade. Final completion is carried out with initial functional testing to ensure the machine is ready for commissioning (D. Wijaya & al., 2022).

#### 6. Machine Performance Testing

The test stage is carried out to evaluate the machine's ability to cut aluminum. The test parameters include cutting speed, quality of cut results, energy efficiency, and machine noise level during operation. This process is carried out using several standard-sized aluminum samples to obtain replicable results. The data obtained is statistically analyzed to find out whether the machine meets the designed specifications (Rahman & al., 2020).

#### 7. Data Analysis and Evaluation

The data obtained from the test was analyzed using quantitative methods. This analysis includes calculations of the energy efficiency of the machine, the durability of the saw blade, and the level of surface roughness of the aluminum piece. In addition, the test results are compared with conventional aluminum cutting machines to assess the advantages of the new design. The main findings of this analysis are used to provide suggestions for improvement if needed (Firmansyah & al., 2019).

### **RESULTS**

This research succeeded in producing a cutting saw machine that is specially designed to meet the needs of cutting aluminum materials effectively and efficiently. The machine is designed as a solution to increase productivity and reduce reliance on time- and labor-intensive manual cutting methods. The main results of this study can be explained in detail as follows:

#### 1. Machine Design and Specification

The developed cutting saw machine is designed with the aspects of efficiency, ease of use and reliability in mind. Some of the main components that are part of this machine are:

- a) **Saw Frame:**  
This machine uses a saw frame made of elbow iron with a thickness of 3 mm. Elbow irons are chosen because of their high strength to support various engine components. The frame also serves as the foundation for bearing mounts, dynamos and other mechanical systems.
- b) **Shaft:**  
The engine shaft is made of ST 37 iron with an original diameter of 22 mm, which is turned to a tiered diameter, namely 17 mm and 18 mm, according to the design requirements. This shaft has an important role in transmitting rotation from the dynamo to the saw blade.
- c) **Dynamo:**  
This machine uses a washer-dryer dynamo with a rotation speed of 900 RPM as the main drive. This dynamo was chosen because of its efficiency in converting electrical energy into mechanical movement, as well as its ability to work stably.
- d) **Saw Blade:**  
The small saw blade used is capable of cutting aluminum with high precision. These saw blades are designed to be easily replaced, thus providing flexibility for users to adjust the type of saw blade according to their cutting needs.
- e) **Additional Components:**  
Several additional components, such as seat bearings, hollow iron, and ironwood boards, are used to ensure the stability of the machine and provide ease of operation.

## 2. Manufacturing and Assembly Process

The manufacturing and assembly process of this machine is carried out in stages, from design to final testing. The main steps taken include:

- a) **Preparation of Materials and Tools:**  
All necessary materials and tools, such as elbow irons, iron plates, seat bearings, and cutting tools (grinders, drills, and welding machines), are prepared according to the specifications that have been designed.
- b) **Forming and Cutting:**  
The main materials, such as elbow irons and iron plates, are cut to size using precision cutting tools. Hollow iron is formed into a strip for the movement of the saw blade.
- c) **Component Assembly:**  
All components are assembled into a single machine. Seat bearings are installed to support the shaft, while the dynamo is connected to the shaft using pulleys. The mechanical system of the saw blade is arranged to allow for a stable back-and-forth movement.



Figure 1. Chainsaw Machine

d) Initial Testing:

Once the assembly process is complete, the machine is tested to ensure all components are working properly. Initial testing involves checking the shaft, dynamo, and saw blade.

3. Machine Performance Testing

Machine performance testing is carried out to evaluate efficiency, stability, and cutting ability. The test results show that the machine has satisfactory performance in terms of:

a) Cutting Speed:

The machine is capable of cutting aluminum at a speed of 86.13 mm/min, which is calculated based on the rotational speed of the dynamo (900 RPM) and the length of the saw stroke (76.2 mm).

b) Energy Efficiency:

The use of a small dynamo as the main drive allows the machine to work with low energy consumption, making it suitable for small-scale applications.

c) Operational Stability:

The designed mechanical system allows the saw blade to move stably, without excessive vibration. This improves the precision of the cut result.

d) Ease of Maintenance:

The machine is designed to be easy to maintain. The saw blade can be replaced quickly, and components such as shafts and bearings are easily accessible for cleaning or repair.

## DISCUSSION

This designed cutting saw machine offers high efficiency in time and power, as it is able to shorten the duration and effort required to cut aluminum compared to manual methods. Its ergonomic design ensures ease of use, even for operators with minimal experience. In addition, the machine has a compact size, making it easy to move to various job sites as needed. From an economic point of view, the cost of manufacturing this machine is very affordable because it utilizes materials such as scrap iron plates and washing machine dynamos, without compromising the quality and reliability of the tool.

In terms of cost, this machine is designed as a cost-saving solution. The total cost of production includes the purchase of key materials such as elbow iron, iron plates, and dynamos, as well as the operational costs of tools such as welding machines and drills. The use of used materials that are still suitable for use also makes a significant contribution to reducing overall costs.

Once assembly and testing are complete, these machines go through a finishing process to improve durability and aesthetics. The painting process using spray paint not only provides protection against rust but also improves the overall appearance of the machine. Furthermore, a re-inspection of all components is carried out to ensure that there is no damage or looseness of the joint. The engine was then retested to ensure that its performance matched the original design and specifications.

This machine is designed to be applied to small to medium-scale activities, such as in metal workshops or small factories that require efficient aluminum cutting. With a simple yet functional design, this machine can be operated easily by various people, from professional technicians to novice operators.

## **CONCLUSIONS AND RECOMMENDATIONS**

The development of an efficient and ergonomic aluminum cutting saw machine has been the focus of various previous researches. Study by (Munbais, 2019) highlighting the importance of vise components in the stability and cutting precision of metal sawing machines. Moreover (Yulant, 2019) discusses the improvement of the drive system on the same metal saw machine to improve the efficiency and performance of the machine. Other research by (Munbais, 2019) examines the manufacture of vises on Great Captain chainsaws, which emphasizes the important role of these components in the cutting process. These studies provide valuable insights into the design of an efficient, ergonomic, and economical aluminum cutting saw.

## **FURTHER STUDY**

Further research can be focused on increasing the cutting capacity of sawing machines to handle aluminum materials with more varied dimensions and thicknesses. This effort can involve the use of drive motors with greater power as well as more powerful mechanical systems. In addition, the development of automation features is also an important step. The addition of microprocessor-based control technology or PLC (Programmable Logic Controller) can allow automatic adjustment of cutting speed, step length, and cutting pressure, thereby improving the efficiency and accuracy of machine work.

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